Powder River Basin Resource Council * Pavillion Area Concerned Citizens * Western Organization of Resource Councils * Earthworks * Natural Resources Defense Council

March 18, 2016

Mr. Kevin Frederick
Wyoming DEQ
Attn: Water Quality Division, Pavillion Study
200 West 17th Street
Cheyenne, WY 82002

RE: Comments on Pavillion Water Well Report and Palatability Study AME, Inc. December 14, 2015

Dear Mr. Frederick:

The Powder River Basin Resource Council and Pavillion Area Concerned Citizens submit the following and attached comments regarding the above referenced report on behalf of our members who live and work in the Pavillion area. These Wyoming citizens have had their lives turned upside down by the intensive oil and gas development that has taken place near their homes over the years. They have suffered serious impacts to their health, their water, their real property and their way of life. The time has come for Wyoming to address the multitude of problems identified in this and other reports. Our comments are also endorsed by the additional groups signing onto these comments and standing in solidarity with our comments and requests.

The attached technical comments are from Mike Wireman, a hydro-geologist who reviewed the report on behalf of the Powder River Basin Resource Council. We are in agreement with Mr. Wireman's comments regarding the report and we concur with his overall assessment, which states:

> ***"It is important to recognize that the Pavillion Gas Field is a large industrial operation which utilizes a variety of industrial chemicals which can infiltrate into the sub-surface and contaminate shallow groundwater. Production of gas has clearly resulted in enhanced migration of thermogenic gas which has contaminated shallow groundwater in the upper part of the Wind River Formation and contaminated a number of domestic/stock wells. Given the extent of the contamination I suggest that the Pavillion Gas Field be considered a major groundwater contamination site that should be regulated and remediated."***

We support Wireman's review of the Pavillion report and his recommendations. We are especially concerned about the following issues he highlights which are identified in the DEQ's Pavillion report:

- A lack of casing identified in several gas wells and leakage from gas wells indicating pathways for extensive gas migration to the shallow aquifer. Why didn't WOGCC require production casing to be cemented to the surface? Has this failing been fixed?
- The down spacing of gas wells in the Pavillion area from one well every 640 acres to one well every 40 acres which led to and an increase in production and resulted in a huge increase in pathways for migration of gas and other pollutants. Will this practice be altered?
- Why did Wyoming fail to limit extensive oil and gas drilling so close to domestic and stock wells and within a freshwater aquifer? Will this practice be changed?
- The detection of petroleum constituents, organic and volatile organic compounds and dissolved methane in domestic water wells. Will WDEQ do more to determine the source of these pollutants?
- Why were only 14 water supply wells sampled out of nearly 100 water wells in the area? Will WDEQ sample more of them?
- Dissolved methane leading to an increase of iron bacteria and sulfate reducing bacteria that lead to foul water.
- The failure to assess and remediate 55 unlined production pits in the Pavillion Gas Field, many of which are near domestic water wells. These pits remain a potentially significant source of groundwater contamination. Does WDEQ intend to remediate all these pits?

Despite these clear findings the report for DEQ erroneously concludes that existing data are insufficient to demonstrate that the presence of methane or the changes in water quality are associated with gas development. Hydro-geologist Mike Wireman counters that statement and states:

> ***"In my opinion the data, while limited spatially and temporally, clearly indicate hydrocarbon contamination of shallow groundwater, which if considered along with the increased gas well spacing density and the obviously common wellbore integrity pathways, is convincing evidence that the development of gas from the Pavillion field has increased the migration of thermogenic gas upward into shallow water bearing zones of the Wind River Formation and resulted in contamination of numerous water supply wells."***

In addition to Mr. Wireman's attached comments we would like to emphasize his following detailed comments and observations regarding the study:

THE PATH OF THE PREHISTORIC WIND RIVER UNDERLYING THE PAVILLION FIELD AND INTERCONNECTION OF WATER BEARING SANDSTONE DEPOSITS CREATE THE POTENTIAL FOR MIGRATION OF CONTAMINANTS ASSOCIATED WITH HYDRAULIC FRACTURING.

On Page 19 of the report it is correctly stated that "*sandstone and conglomerate bodies vary in size and geometry, and have a range of hydraulic interconnection...Fractures may enhance permeability of sandstones in areas of structural deformation (USGS).*" It is also correctly stated that, "*Differences in water levels as much as 140 feet have been measured in adjacent water-supply wells completed at different depths.*" However, in this paragraph, it is also stated that "*Individual lenticular sand bodies may be considered as separate aquifers on a local scale.*" In areas of structural deformation, as is the case for the Pavillion field, fracture systems would be expected to result in hydraulic interconnection, therefore, the term "*separate aquifers*" is not applicable in the Pavillion Field. Equally important, on page 18 it is mentioned, but not discussed, that, "*Paleocurrent studies have mapped the course of the Eocene paleo-wind river flowing to the east-southeast through the Pavillion area.*" The presence of paleo-channels in the Pavillion field is relevant to interconnection of water-bearing sand stone deposits and potential offsite migration of contaminants associated with hydraulic fracturing.

The central part of the Wind River Basin where the Pavillion Field lies is characterized by stream-valley fill and broad flood plains. The presence of large quantities of overbank mudstones and near linear channel-sandstone ridges suggest that meandering streams of low sinuosity were dominant during deposition of the Wind River Formation (Seeland 1978). The Eocene (34 – 55 Mya) Wind River flowed directly through an area that is now the Pavillion Field in the vicinity of production well Tribal Unit 14X-11 (Seeland 1978). Inspection of the figures generated by Seeland (1978) indicates that major tributaries of the Eocene Wind River ran directly north and south of Pavillion Field. Maximum intervals of continuous sandstone deposits are greatest near the course of the Eocene Wind River (Seeland 1978).

Gores and Associates (2011) used geophysical logs from production wells and lithologic information from domestic wells to determine whether white coarse sand deposits targeted by local water well drillers were correlated with the flow path(s) of the Eocene Wind River and associated channel or tributaries. Gores and Associates (2011) state that: it appears that there is a reasonable correlation between the coarse white sand lens in private domestic wells and oil and gas wells; the gentle dip to the southeast parallels the mapped paleo-Wind River channel; and static water levels in domestic wells appear fairly uniform with a slight dip to the southeast which generally parallels the dip of the sand bodies in the formation. Based on these observations, Gore and Associates recommended proposed municipal well installation at two locations, both approximately 1000 feet below ground surface (bgs).

THE NEARLY 50 UNLINED PITS IN THE PAVILLION GAS FIELD NEAR DOMESTIC WATER WELLS ARE A SIGNIFICANT SOURCE OF GROUNDWATER CONTAMINATION.

There may be as many as 48 domestic wells within 2,000 feet of unlined pits. Why were only 14 domestic wells near pits sampled? The chemical 2-Butoxyethanol, which was widely used for hydraulic fracturing in the Pavillion field was detected at 3,300 ug/L in a domestic well. The depth of this domestic well is only 30 feet below ground surface and is located within 440 feet of an unlined pit used for disposal of production fluids. Other compounds, including BTEX, associated with production well stimulation (e.g. isopropanol) were detected at lower concentrations in other domestic wells. Sample results at domestic wells indicate the need for further investigation, which must include the installation of monitoring wells. Since flood irrigation is common in the vicinity of unlined pit areas, the lateral extent of groundwater

contamination is potentially greater in the Wind River Formation than in Quaternary deposits due to the potential for uncontaminated water to overlay portions of a contaminant plume.

WYOMING HAS PERMITTED OIL AND GAS DEVELOPMENT IN DRINKING WATER AQUIFERS IN THE PAVILLION FIELD

A number of confusing and erroneous comments and arguments discussed in the report challenge the designation of the Wind River and Fort Union Formations as Underground Sources of Drinking Water (USDWs). The first argument is based on the State of Wyoming's interpretation of delegation of the federal Underground Injection Control (UIC) program to the State of Wyoming on July 15, 1983. It is stated on page 25 of the report that by delegating administration of the UIC program to the State of Wyoming, the EPA "*accepted Wyoming's regulations describing its groundwater classification system.*" Also on page 25, it is stated that, "*Wyoming's classification system also includes a class of groundwater (Class 6) that recognizes some groundwater is 'Unusable' or 'Unsuitable' for any purpose due to the presence of contaminants or high (>5,000mg/L) TDS, or because it is located (including depth below the surface) such that any use is technologically or economically impractical.*" The federal UIC program requires all groundwater less than 10,000 mg/L TDS to be protected. Wyoming's interpretation of the regulations violate the federal requirement and fail to protect groundwater resources by allowing contamination in aquifers with a level of 5,000 mg/L TDS rather than the more stringent10,000 mg/L TDS.

In addition, the WDEQ Chapter 8 Water Quality Standards for Wyoming Groundwater list no concentration of TDS that is actually specified for "*excessive concentration of total dissolved solids*" for Class 6 groundwater categorized as "*unusable or unsuitable for use.*" Yet the report states there is a 5,000 mg/L threshold for Class 6 groundwater. A limit of 5,000 mg/L is specified for livestock use for Class 3 groundwater in Wyoming regulations -- not Class 6 groundwater. Thus, in contrast to a statement in the report, there does not appear to be an explicit TDS threshold for Class 6 groundwater in Wyoming regulations.

The report further confuses the issue by making the argument that deeper groundwater is unusable or unsuitable based on TDS levels of produced water from oil and gas production. On page 26, the report says that "*In 47 produced water samples, taken from permeable zones deeper than the well and spring sample, TDS concentrations ranged from 1060 to 38,800 mg/L; and the 75th percentile concentrations was 4,860 mg/L." (WSGS 2012).*

It is important to note that produced water samples were collected in 2007, subsequent to hydraulic fracturing in these production wells which was not discussed in the Wyoming DEQ report. Produced water samples are not representative of baseline Wind River and Fort Union Formations. These produced water samples have been enriched in potassium and chloride due to extensive use of KCl solutions used during hydraulic fracturing.

In investigating locations for one or two municipal wells to replace domestic wells in the Pavillion Field, Gore and Associates (2011) postulated that lower TDS levels in the Wind River Formation could be associated with lithology – specifically white coarse sand deposits. Domestic well drillers often target these deposits (Gore and Associates 2011). Morris et al. (1959) referred to white coarse-grained sandstone deposits as "*water sands.*" White coarse sand deposits are described in the driller's logs and inferred from geophysical logs with porosity approaching 30% (Gore and Associates 2011). According to several reports and data sets, there are no apparent trends in TDS with depth. These include data sets from the WRIR USGS report

(Daddow 1992), Fremont County USGS report (Plafcan et al. 1995), and domestic wells in and around the Pavillion Field. In fact, the Plafcan et al. report in 1995 documented a TDS concentration of 1190 mg/L at 2200 ft bgs in the Wind River Formation.

CONCLUSION

This report, combined with the two previous reports regarding the Pavillion contamination, clearly identifies a serious failure by the State of Wyoming to ensure protection of the drinking water aquifer and water supply wells in the Pavillion area. Instead, the state permitted a massive expansion of gas drilling in the Pavillion area while failing to ensure the gas wells were adequately cased to keep pollutants and methane gas from escaping into the aquifer. Furthermore, the state failed to ensure production pits were lined so that drilling fluids would not contaminate the shallow aquifer. Wyoming's lax permitting and weak regulatory environment caused the contamination of the Wind River aquifer and of Wyoming citizens' water wells in the Pavillion area. The state of Wyoming should accept responsibility and provide a long-term supply of clean water for Pavillion area residents and remediate the contamination without delay.

Respectfully submitted,

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enc. Wireman Attachment